Applicants thank the Examiner for the indication of allowable subject matter.

Claims 1-8 stand rejected under 35 U.S.C. § 102(e) as anticipated by Christopher. This rejection is respectfully traversed.

The present invention as recited in Claim 1 is directed to an ultrasonic diagnostic apparatus for scanning a subject to be examined with an ultrasonic pulse. The apparatus includes transmitting means for transmitting the ultrasonic pulse a plurality of times along each scanning line set to a region to be scanned in the subject in order to produce a single image of the region, in which a transmission characteristic of the ultrasonic pulse transmitted every time the ultrasonic pulse is transmitted along each scanning line for producing the image is different from one another. The apparatus also includes receiving means for receiving an ultrasonic echo signal returned when the ultrasonic pulse is reflected or scattered in the subject, and acquiring an electrical reception signal that corresponds to the ultrasonic echo signal, and filter means for applying filtering processing to each reception signal acquired by the receiving means, in which a characteristic of the filtering processing applied to each of the reception signals acquired along each scanning line is different from one another. Also included is synthesizing means for synthesizing the plurality of reception signals, scanning line by scanning line, filtering-processed by the filter means, producing means for producing image data of the region using the reception signals synthesized by the synthesizing means, and display means for displaying the image data produced by the producing means. In addition, new Claim 22 is similar to Claim 1, but has been drafted to not use means-plus-function terminology.

The outstanding Office Action indicates Christopher teaches the claimed invention including an ultrasound diagnostic apparatus having a transmission and receiving means, a filter means, a synthesizing means and a means for generating an image for display and cites

Figure 1. However, Applicants note Christopher differs from the claimed invention for the following reasons. In Christopher, a system 10 (see Figure 1) can be operated in a two pulse scheme or mode. In this mode of operation, system 10 generates and transmits into sample 24 two different pulses. The transmitted signals are identical except that one of them is scaled up in pressure. The pulses are transmitted one after another, with for example, approximately 1/4,000 second intervals between them. The reflected signals from both pulses are subjected to various types of reception processing, before being subjected to subtraction one from the other to produce a difference or resultant signal use for displaying images (see column 3, lines 52-64).

On the contrary, the present invention is provided to broaden the frequency bandwidth of a particular signal component, for example, a harmonic signal component of an ultrasonic signal to be transmitted (see page 4, the second paragraph). To accomplish such an object, the claimed structure:

(i) transmits the ultrasonic pulse a plurality of times along each scanning line set to a region to be scanned in the subject to produce a single image of the region, a transmission characteristic of the ultrasonic pulse transmitted every time the ultrasonic pulse is transmitted along each scanning line being different from one another;

(ii) applying filtering processing to each reception signal, a characteristic of the filtering processing applied to each of the reception signals acquired along each scanning line being different from one another; and

(iii) synthesizing the plurality of filtering-processed reception signals, scanning line by scanning line.

Christopher does not teach or suggest the above claimed combination. Further, as noted above, Christopher discloses a subtraction (one from the other) in the two pulse scheme

or mode, whereas the present invention provides a synthesis (i.e., addition) technique required for a broadened bandwidth of the harmonic component signal. Accordingly, Christopher cannot produce the advantages of the claimed invention (see page 22, line 3 - page 24, line 18 for the advantage of the present invention).

Accordingly, it is respectfully submitted that independent Claims 1 and 22 and each of the claims depending therefrom patentably define over Christopher.

Claims 20 and 21 stand rejected under 35 U.S.C. § 103(a) as unpatentable over Christopher in view of Averkiou et al. This rejection is respectfully traversed.

Independent Claim 20 includes similar features to that as discussed above with respect to independent Claims 1 and 22. As noted in the discussion above, Christopher does not teach or suggest these features. Further, it is respectfully submitted Averkiou et al also do not teach or suggest these features. Therefore, it is respectfully requested this rejection also be withdrawn.

In addition, the specification has been amended to correct a minor informality and no new matter has been added.

Consequently, in light of the above discussion and in view of the present amendment, the present application is believed to be in condition for allowance and an early and favorable action to that effect is respectfully requested.

Respectfully submitted,

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IN THE SPECIFICATION

Please replace the paragraph beginning at page 19, line 21 through page 20, line 4 as follows:

The ultrasonic echo signal including the described fundamental component and harmonic component is received by the [prove] probe 11 for each rate, and is outputted as a receiving signal. Then, the receiving signal is amplified by means of a preamplifier unit 21, the amplified signal is subjected to receiving beam forming by means of the receiving delay circuit 22, and the beam formed signal is focused on a beam on a scanning line. This beam formed receiving signal is further subjected to quadrature phase wave detection by using a reference signal in the synthesizing processor 32. The phase wave detected signals at a real part and an imaginary part are delivered to the filter 32.

IN THE CLAIMS

--1. (Amended) An ultrasonic diagnostic apparatus for scanning a subject to be examined with an ultrasonic [pulses] pulse, the apparatus comprising:

[a transmission] transmitting means for transmitting the ultrasonic [pulses to] pulse a plurality of times along each scanning line [of the scan a plurality of times] set to a region to be scanned in the subject in order to produce a single image of the region, a transmission

characteristic of the ultrasonic pulse transmitted every time the ultrasonic pulse is transmitted along each scanning line for producing the image being different from one another;

[a] receiving means for receiving an ultrasonic echo signal returned when the ultrasonic [pulses are] pulse is reflected or scattered in the subject, and acquiring an electrical [receiving] reception signal that corresponds to the ultrasonic echo signal;

[a] filter means for applying [filter] filtering processing to each reception signal acquired by the receiving means, a characteristic of the filtering processing applied to each of the reception signals acquired along each scanning line being different from one another [with characteristics that are different depending on a respective one of the plurality of receiving signals each corresponding to the ultrasonic echo signal];

[a] synthesizing means for synthesizing the plurality of [receiving] reception signals, scanning line by scanning line, filtering-processed [processed] by [this] the filter means;

[a generating] producing means for [generating an] producing image data of the region using the [receiving] reception signals synthesized by [this] the synthesizing means; and

[a] display means for displaying the image [generated] data produced by [this generating] the producing means.

2. (Amended) The ultrasonic diagnostic apparatus as claimed in claim [1] 22, wherein the transmitting unit is configured to change a center frequency of the ultrasonic pulse [the ultrasonic pulses transmitted by the transmission means are different from each other at its center frequency] every time [repeated transmission relevant] the ultrasonic pulse is transmitted along [to] each scanning line [is carried out] in order to produce the image.

3. (Amended) The ultrasonic diagnostic apparatus as claimed in claim [1] 22, wherein the transmitting unit is configured to transmit the ultrasonic pulse of which

frequency bandwidth is narrow [the ultrasonic pulses transmitted by the transmission means has a narrow frequency bandwidth] to an extent such that [the] a signal component of the reception signal corresponding to [the] a harmonic component of the ultrasonic pulse that has been transmitted is separable [can be easily separated] from [the] a signal component of the reception signal [that corresponds to the] corresponding to a fundamental component of the ultrasonic pulse that has been transmitted.

4. (Amended) The ultrasonic diagnostic apparatus as claimed in claim [1] 22, wherein the filter [means] is [a means for sampling] configured to sample, every time the ultrasonic pulse is transmitted, from the [receiving] reception signal, [the] a signal component corresponding to [the] a harmonic component of the ultrasonic pulse that has been transmitted and the synthesizing unit is configured to mutually synthesize the harmonic components filtered by the filter in response to transmitting the ultrasonic pulse along each scanning line for producing the image.

5. (Amended) The ultrasonic diagnostic apparatus as claimed in claim 4, wherein [a] the signal component corresponding to the harmonic component, which is synthesized by the synthesizing [means has a wider] unit, is broader in a bandwidth than [that of a] the harmonic component obtained by one time of both the transmission/reception and [filter] the filtering processing [of the ultrasonic pulses].

6. (Amended) The ultrasonic diagnostic apparatus as claimed in claim 4, wherein the harmonic component is a signal component that corresponds to a sub-harmonic component of the ultrasonic [pulses] pulse, the sub-harmonic component being generated [by the] due to a non-linear behavior of an ultrasonic contrast medium administered [to] into the subject.

7. (Amended) The ultrasonic diagnostic apparatus as claimed in claim 4, wherein the filter is configured to change the characteristic [changes filter characteristics] of the [filter]

filtering processing according to [the] a depth in [said] a direction of each scanning line direction, [and comprises a means for executing filter processing with characteristics in which the fundamental component of the ultrasonic pulses remains positively in a predetermined amount] the characteristic of the filtering processing being determined so that a predetermined amount of a signal component corresponding to a fundamental component of the ultrasonic pulse is positively left in a filtered signal.

8. (Amended) The ultrasonic diagnostic apparatus as claimed in claim [1] 22, wherein [a synthesizing process carried out by] the synthesizing [means is a process for adding] unit is configured to add the plurality of [receiving] reception signals filtering-processed by the filter correspondingly to each scanning line.

9. (Amended) The ultrasonic diagnostic apparatus as claimed in claim [1] 22, further comprising [means for changing] a changing unit configured to change, every time the ultrasonic pulse is repeatedly transmitted along each scanning line a plurality of times, at least one of [parameter of the] parameters including a center frequency and a frequency bandwidth of the ultrasonic pulse [pulses every time the ultrasonic pulses are repeatedly transmitted to such each scanning line a plurality of times], [the] an amplitude of the ultrasonic [pulses] pulse, an aperture [during transmission of] for transmitting the ultrasonic [pulses] pulse, a focus obtained when the ultrasonic [pulses are focused in a beam shape] pulse is beam-formed, [and] a receiving gain [relevant to the receiving] for the reception signal, and an addition coefficient for obtaining the reception signal.

10. (Amended) The ultrasonic diagnostic apparatus as claimed in claim [1] 22, wherein the transmitting unit is configured to transmit the ultrasonic [pulses transmitted by the transmission means has] pulse having a frequency bandwidth at which a first signal component of the reception signal corresponding to [the] a harmonic component of the

ultrasonic pulse [in the receiving signal] and a second signal component of the reception signal corresponding to [the] a fundamental component of the ultrasonic pulse are partially [superimposed] overlapped on each other with regard to spectra of the first and second signal components, and

[wherein] the filter is configured to extract, from the reception signal, every time of transmitting the ultrasonic pulse, [means is a means for sampling] a signal component [in] having a frequency range falling in a frequency range of the harmonic component, but being outside an overlapped frequency range on the fundamental component [free of superimposition on the fundamental component on spectra from the receiving signal, of the signal components each corresponding to the harmonic component, for said each transmission].

11. (Amended) The ultrasonic diagnostic apparatus as claimed in claim [1] 22, wherein the [transmission means may be a means for changing] transmitting unit is configured to change both of the number of times of transmission of the ultrasonic pulse to be transmitted and a center frequency of the ultrasonic pulse to be transmitted each time [the count of plural transmissions of the ultrasonic pulses and the level of the center frequency in each transmission of the ultrasonic pulses] so that physiological attenuation occurring when the ultrasonic pulse and the ultrasonic echo signal propagate through the subject is corrected [at] in the [receiving] reception signal synthesized by the synthesizing [means] unit.

12. (Amended) An ultrasonic diagnostic apparatus for scanning a subject to be examined with an ultrasonic [pulses] pulse, thereby acquiring a harmonic image, said apparatus comprising:

a [transmission means for transmitting] transmitting unit configured to transmit the ultrasonic [pulses] pulse a plurality of times along each scanning line set to a region to be

scanned in the subject in order to produce a single image of the region, the ultrasonic pulse having a narrow-bandwidth spectrum [characteristics a plurality of times] characteristic set to such an extent [such] that a signal component corresponding to a harmonic component of the ultrasonic pulse [can be easily separated] is separable from a signal component [that corresponds to its] corresponding to a fundamental component of the ultrasound pulse [with respect to each scanning line of the scan];

a receiving/processing unit configured to receive [receive processing means for receiving the] an echo signal of the ultrasonic pulse [pulses over the plural times of transmissions] responsively to each of the plurality of times of transmission of the ultrasonic pulse along each scanning line, [thereby forming] and processing the echo signal received each time into a harmonic signal having a [wide-bandwidth] broader-bandwidth spectrum [characteristics] characteristic; and

an image producing unit configured to produce [generating means for generating the] a harmonic image from [this] the harmonic signal.

13. (Amended) An ultrasonic imaging method in which [for scanning ultrasonic pulses to be transmitted to] a subject to be examined is scanned by an ultrasonic pulse transmitted, [acquiring] an electrical [receiving] reception signal that corresponds to an ultrasonic echo signal returned when the ultrasonic [pulses are] pulse is reflected or scattered in the subject is acquired, and [acquiring] an image [in a scan] of a region scanned in the subject is obtained from the [receiving] reception signal, said method comprising the steps of:

executing transmission of the ultrasonic [pulses] pulse, [receiving] reception of [an] the echo signal, and acquisition of [a receiving] the reception signal, the transmission and the reception being carried out a plurality of times [for] along each scanning line [of a scan] forming the region to be scanned in order to produce a single image of the region;

applying [filter] filtering processing to each reception signal acquired, a characteristic of the filtering processing applied to each of the reception signals acquired along each scanning line being different from one another [with characteristics that are different depending on a respective one of a plurality of receiving signals to be received, to each scanning line];

synthesizing the plurality of processed [receiving] reception signals [are synthesized] with each other, scanning line by scanning line;

[generating the] producing image data of the region scanned by using the synthesized [receiving signal] reception signals; and

displaying [the] an image based on the produced image data.

14. (Amended) The ultrasonic imaging method as claimed in claim 13, wherein the transmitted ultrasonic [pulses are] pulse is different from each other [at its] with respect to a center frequency thereof every time the ultrasonic pulse [transmission] is [repeatedly carried out for] transmitted along each scanning line.

15. (Amended) The ultrasonic [diagnostic apparatus] imaging method as claimed in claim 13, wherein the transmitted ultrasonic pulse has a narrow frequency bandwidth set to such an extent [such] that a signal component of the reception signal corresponding to [the] a harmonic component of the ultrasonic pulse [pulses in a receiving signal can be easily separated] is separable from a signal component of the reception signal corresponding to [its] a fundamental component of the ultrasonic pulse.

16. (Amended) The ultrasonic diagnostic apparatus as claimed in claim 13, wherein [filter] the filtering processing is set to a process for sampling, every time the ultrasonic pulse is transmitted, from [a receiving] the reception signal, a signal component that corresponds to [the] a harmonic component of the ultrasonic [pulses every transmission] pulse.

17. (Amended) The ultrasonic diagnostic apparatus as claimed in claim 16, wherein [a] the signal component corresponding to the harmonic component, which is synthesized at the synthesizing step is broader in a [has a wider] bandwidth than [that of] the harmonic component obtained by one [transmission/receiving] time of both the transmission/reception and the filtering [of the ultrasonic pulses] processing.

18. (Amended) The ultrasonic diagnostic apparatus as claimed in claim [13] 15, wherein the harmonic component [is] corresponds to a second harmonic component of the ultrasonic [pulses] pulse generated [by the] due to either a non-linearity of physiological tissues of [a] the subject or a [second harmonic component of ultrasonic pulses generated by the] non-linear behavior of [the] an ultrasonic contrast medium administrated [to the non-linearity of the physiological tissues of] into the subject.

19. (Amended) The ultrasonic diagnostic apparatus as claimed in claim 13, further comprising the step of changing, every time the ultrasonic pulse is repeatedly transmitted along each scanning line a plurality of times, at least one of [parameter] parameters including [of at least one of the] a center frequency and a frequency bandwidth of the ultrasonic [pulses] pulse; [a bandwidth] an amplitude of the ultrasonic [pulses] pulse; an aperture [during transmission of] for transmitting the ultrasonic [pulses] pulse; a focus obtained when the ultrasonic [pulses are focused in a beam shape] pulse is beam-formed; [and] a receiving gain [relevant to the receiving] for the reception signal; and an addition coefficient for obtaining the reception signal [every time the ultrasonic pulses are repeatedly transmitted to such each scanning line a plurality of times].

20. (Amended) An ultrasonic diagnostic apparatus for scanning a subject to be examined with an ultrasonic [pulses, thereby acquiring] pulse in order to acquire a harmonic image of the subject, said apparatus comprising:

a [transmission means for transmitting] transmitting unit configured to transmit the ultrasonic [pulses] pulse a plurality of times along each scanning line set to a region to be scanned in the subject in order to produce a single image of the region, the plurality of times of the ultrasonic pulses to be transmitted including two types of the ultrasonic pulses of which signal polarities are opposite to each other, each type of the ultrasonic pulse being further transmitted a plurality of times, [having their two polarities inverted each other for each scanning line in which ultrasonic pulses are to be scanned], a transmission characteristic of the ultrasound pulse belonging to each type being different one from the other;

a receiving [means for acquiring] unit configured to receive an electrical [receiving] reception signal that corresponds to [a] an ultrasonic echo signal returned [when the ultrasonic pulses are reflected or scattered in] from the subject every time of [such] transmission of the ultrasonic pulse;

a synthesizing [means for synthesizing] unit configured to mutually add, between the two types of transmission, the reception signals to produce a plurality of harmonic components depending on the restrictive transmission characteristics and to mutually synthesize, every type of transmission, the plurality of [receiving signals so as] harmonic components to [widen the] broaden a bandwidth of [a] the harmonic component relevant to [the] a fundamental component of the ultrasonic [pulses] pulse; and

an image [generating means for generating a] producing unit configured to produce the harmonic image from the harmonic component of which bandwidth is [widened in bandwidth] broadened by the synthesizing [means] unit.

21. (Canceled)

22. (New).--